



## SUBSTITUTE SEQUENCE LISTING

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<120> THERMAL TOLERANT EXOGLUCANASE FROM ACIDOTHERMUS  
CELLULOLYTICUS

<130> 40197.5US01

<140> 09/917,384  
<141> 2001-07-28

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<170> PatentIn Ver. 2.1

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35 40 45

Pro Ser Asp Asn Gln Ile Lys Pro Gly Leu Gln Leu Val Asn Thr Gly  
50 55 60

Ser Ser Ser Val Asp Leu Ser Thr Val Thr Val Arg Tyr Trp Phe Thr  
65 70 75 80

Arg Asp Gly Gly Ser Ser Thr Leu Val Tyr Asn Cys Asp Trp Ala Ala  
85 90 95

Met Gly Cys Gly Asn Ile Arg Ala Ser Phe Gly Ser Val Asn Pro Ala  
100 105 110

Thr Pro Thr Ala Asp Thr Tyr Leu Gln Leu Ser Phe Thr Gly Gly Thr  
115 120 125

Leu Ala Ala Gly Gly Ser Thr Gly Glu Ile Gln Asn Arg Val Asn Lys  
130 135 140

Ser Asp Trp Ser Asn Phe Asp Glu Thr Asn Asp Tyr Ser Tyr Gly Thr  
145 150 155 160

Asn Thr Thr Phe Gln Asp Trp Thr Lys Val Thr Val Tyr Val Asn Gly  
165 170 175

Val Leu Val Trp Gly Thr Glu Pro Ser Gly Ala Thr Ala Ser Pro Ser  
180 185 190

Ala Ser Ala Thr Pro Ser Pro Ser Ser Ser Pro Thr Thr Ser Pro Ser  
195 200 205

Ser Ser Pro Ser Pro Ser Ser Pro Thr Pro Thr Pro Ser Ser Ser  
210 215 220

Ser Pro Pro Pro Ser Ser Asn Asp Pro Tyr Ile Gln Arg Phe Leu Thr  
225 230 235 240

Met Tyr Asn Lys Ile His Asp Pro Ala Asn Gly Tyr Phe Ser Pro Gln  
245 250 255

Gly Ile Pro Tyr His Ser Val Glu Thr Leu Ile Val Glu Ala Pro Asp  
260 265 270

Tyr Gly His Glu Thr Thr Ser Glu Ala Tyr Ser Phe Trp Leu Trp Leu  
275 280 285

Glu Ala Thr Tyr Gly Ala Val Thr Gly Asn Trp Thr Pro Phe Asn Asn  
290 295 300

Ala Trp Thr Thr Met Glu Thr Tyr Met Ile Pro Gln His Ala Asp Gln  
305 310 315 320

Pro Asn Asn Ala Ser Tyr Asn Pro Asn Ser Pro Ala Ser Tyr Ala Pro  
325 330 335

Glu Glu Pro Leu Pro Ser Met Tyr Pro Val Ala Ile Asp Ser Ser Val  
340 345 350

Pro Val Gly His Asp Pro Leu Ala Ala Glu Leu Gln Ser Thr Tyr Gly  
355 360 365

Thr Pro Asp Ile Tyr Gly Met His Trp Leu Ala Asp Val Asp Asn Ile  
370 375 380

Tyr Gly Tyr Gly Asp Ser Pro Gly Gly Cys Glu Leu Gly Pro Ser  
385 390 395 400

Ala Lys Gly Val Ser Tyr Ile Asn Thr Phe Gln Arg Gly Ser Gln Glu  
405 410 415

Ser Val Trp Glu Thr Val Thr Gln Pro Thr Cys Asp Asn Gly Lys Tyr  
420 425 430

Gly Gly Ala His Gly Tyr Val Asp Leu Phe Ile Gln Gly Ser Thr Pro  
435 440 445

Pro Gln Trp Lys Tyr Thr Asp Ala Pro Asp Ala Asp Ala Arg Ala Val  
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Gln Ala Ala Tyr Trp Ala Tyr Thr Trp Ala Ser Ala Gln Gly Lys Ala  
465 470 475 480

Ser Ala Ile Ala Pro Thr Ile Ala Lys Ala Ser Gln Thr Gly Asp Tyr  
485 490 495

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500 505 510

Tyr Pro Ala Ser Ser Cys Pro Gly Ala Thr Gly Arg Gln Ser Glu Thr  
515 520 525

Tyr Leu Ile Gly Trp Tyr Ala Trp Gly Gly Ser Ser Gln Gly Trp  
530 535 540

Ala Trp Arg Ile Gly Asp Gly Ala Ala His Phe Gly Tyr Gln Asn Pro  
545 550 555 560

Leu Ala Ala Trp Ala Met Ser Asn Val Thr Pro Leu Ile Pro Leu Ser  
565 570 575

Pro Thr Ala Lys Ser Asp Trp Ala Ala Ser Leu Gln Arg Gln Leu Glu  
580 585 590

Phe Tyr Gln Trp Leu Gln Ser Ala Glu Gly Ala Ile Ala Gly Gly Ala  
595 600 605

Thr Asn Ser Trp Asn Gly Asn Tyr Gly Thr Pro Pro Ala Gly Asp Ser  
610 615 620

Thr Phe Tyr Gly Met Ala Tyr Asp Trp Glu Pro Val Tyr His Asp Pro  
625 630 635 640

Pro Ser Asn Asn Trp Phe Gly Phe Gln Ala Trp Ser Met Glu Arg Val  
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Ala Glu Tyr Tyr Tyr Val Thr Gly Asp Pro Lys Ala Lys Ala Leu Leu  
660 665 670

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675 680 685

Trp Ser Ile Pro Ser Asn Leu Ser Trp Ser Gly Gln Pro Asp Thr Trp  
690 695 700

Asn Pro Ser Asn Pro Gly Thr Asn Ala Asn Leu His Val Thr Ile Thr  
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Ser Ser Gly Gln Asp Val Gly Val Ala Ala Ala Leu Ala Lys Thr Leu  
725 730 735

Glu Tyr Tyr Ala Ala Lys Ser Gly Asp Thr Ala Ser Arg Asp Leu Ala  
740 745 750

Lys Gly Leu Leu Asp Ser Met Trp Asn Asn Asp Gln Asp Ser Leu Gly  
755 760 765

Val Ser Thr Pro Glu Thr Arg Thr Asp Tyr Ser Arg Phe Thr Gln Val  
770 775 780

Tyr Asp Pro Thr Thr Gly Asp Gly Leu Tyr Ile Pro Ser Gly Trp Thr  
785 790 795 800

Gly Thr Met Pro Asn Gly Asp Gln Ile Lys Pro Gly Ala Thr Phe Leu  
805 810 815

Ser Ile Arg Ser Trp Tyr Thr Lys Asp Pro Gln Trp Ser Lys Val Gln  
820 825 830

Ala Tyr Leu Asn Gly Gly Pro Ala Pro Thr Phe Asn Tyr His Arg Phe  
835 840 845

Trp Ala Glu Ser Asp Phe Ala Met Ala Asn Ala Asp Phe Gly Met Leu  
850 855 860

Phe Pro Ser Gly Ser Pro Ser Pro Thr Pro Ser Pro Thr Pro Thr Ser  
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885 890 895

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Val Thr Gly Thr Thr Ser Ser Val Ser Leu Ser Trp Thr Ala Ser  
915 920 925

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930 935 940

Leu Val Gly Gln Pro Thr Ala Thr Ser Phe Thr Asp Thr Gly Leu Ala  
945 950 955 960

Ala Gly Thr Ser Tyr Thr Tyr Thr Val Ala Ala Val Asp Ala Ala Gly  
965 970 975

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Val Ala Ser Pro Ser Pro Ser Pro Thr Pro Thr Ser Ser Pro Ser Pro  
995 1000 1005

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Thr Ala Thr Tyr Val Val Asn Ser Asp Trp Gly Ser Gly Phe Thr Thr  
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Thr Val Thr Val Thr Asn Thr Gly Thr Arg Ala Thr Ser Gly Trp Thr  
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Val Thr Trp Ser Phe Ala Gly Asn Gln Thr Val Thr Asn Tyr Trp Asn  
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Tyr Asn Asn Val Ile Gln Pro Gly Gln Ser Thr Thr Phe Gly Phe Asn  
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<212> DNA

<213> Acidothermus cellulolyticus

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<213> Acidothermus cellulolyticus

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<213> Acidothermus cellulolyticus

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Asp Asn Gln Ile Lys Pro Gly Leu Gln Leu Val Asn Thr Gly Ser Ser  
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Ser Val Asp Leu Ser Thr Val Thr Val Arg Tyr Trp Phe Thr Arg Asp  
35 40 45

Gly Gly Ser Ser Thr Leu Val Tyr Asn Cys Asp Trp Ala Ala Met Gly  
50 55 60

Cys Gly Asn Ile Arg Ala Ser Phe Gly Ser Val Asn Pro Ala Thr Pro  
65 70 75 80

Thr Ala Asp Thr Tyr Leu Gln Leu Ser Phe Thr Gly Gly Thr Leu Ala  
85 90 95

Ala Gly Gly Ser Thr Gly Glu Ile Gln Asn Arg Val Asn Lys Ser Asp  
100 105 110

Trp Ser Asn Phe Asp Glu Thr Asn Asp Tyr Ser Tyr Gly Thr Asn Thr  
115 120 125

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<212> PRT

<213> Acidothermus cellulolyticus

<400> 5

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Val Glu Thr Leu Ile Val Glu Ala Pro Asp Tyr Gly His Glu Thr Thr  
35 40 45

Ser Glu Ala Tyr Ser Phe Trp Leu Trp Leu Glu Ala Thr Tyr Gly Ala  
50 55 60

Val Thr Gly Asn Trp Thr Pro Phe Asn Asn Ala Trp Thr Thr Met Glu  
65 70 75 80

Thr Tyr Met Ile Pro Gln His Ala Asp Gln Pro Asn Asn Ala Ser Tyr  
85 90 95

Asn Pro Asn Ser Pro Ala Ser Tyr Ala Pro Glu Glu Pro Leu Pro Ser  
100 105 110

Met Tyr Pro Val Ala Ile Asp Ser Ser Val Pro Val Gly His Asp Pro  
115 120 125

Leu Ala Ala Glu Leu Gln Ser Thr Tyr Gly Thr Pro Asp Ile Tyr Gly  
130 135 140

Met His Trp Leu Ala Asp Val Asp Asn Ile Tyr Gly Tyr Gly Asp Ser  
145 150 155 160

Pro Gly Gly Gly Cys Glu Leu Gly Pro Ser Ala Lys Gly Val Ser Tyr  
165 170 175

Ile Asn Thr Phe Gln Arg Gly Ser Gln Glu Ser Val Trp Glu Thr Val

180	185	190
Thr Gln Pro Thr Cys Asp Asn Gly Lys Tyr Gly Gly Ala His Gly Tyr		
195	200	205
Val Asp Leu Phe Ile Gln Gly Ser Thr Pro Pro Gln Trp Lys Tyr Thr		
210	215	220
Asp Ala Pro Asp Ala Asp Ala Arg Ala Val Gln Ala Ala Tyr Trp Ala		
225	230	235
Tyr Thr Trp Ala Ser Ala Gln Gly Lys Ala Ser Ala Ile Ala Pro Thr		
245	250	255
Ile Ala Lys Ala Ser Gln Thr Gly Asp Tyr Leu Arg Tyr Ser Leu Phe		
260	265	270
Asp Lys Tyr Phe Lys Gln Val Gly Asn Cys Tyr Pro Ala Ser Ser Cys		
275	280	285
Pro Gly Ala Thr Gly Arg Gln Ser Glu Thr Tyr Leu Ile Gly Trp Tyr		
290	295	300
Tyr Ala Trp Gly Gly Ser Ser Gln Gly Trp Ala Trp Arg Ile Gly Asp		
305	310	315
Gly Ala Ala His Phe Gly Tyr Gln Asn Pro Leu Ala Ala Trp Ala Met		
325	330	335
Ser Asn Val Thr Pro Leu Ile Pro Leu Ser Pro Thr Ala Lys Ser Asp		
340	345	350
Trp Ala Ala Ser Leu Gln Arg Gln Leu Glu Phe Tyr Gln Trp Leu Gln		
355	360	365
Ser Ala Glu Gly Ala Ile Ala Gly Gly Ala Thr Asn Ser Trp Asn Gly		
370	375	380
Asn Tyr Gly Thr Pro Pro Ala Gly Asp Ser Thr Phe Tyr Gly Met Ala		
385	390	395
Tyr Asp Trp Glu Pro Val Tyr His Asp Pro Pro Ser Asn Asn Trp Phe		
405	410	415
Gly Phe Gln Ala Trp Ser Met Glu Arg Val Ala Glu Tyr Tyr Tyr Val		
420	425	430
Thr Gly Asp Pro Lys Ala Lys Ala Leu Leu Asp Lys Trp Val Ala Trp		
435	440	445
Val Lys Pro Asn Val Thr Thr Gly Ala Ser Trp Ser Ile Pro Ser Asn		
450	455	460
Leu Ser Trp Ser Gly Gln Pro Asp Thr Trp Asn Pro Ser Asn Pro Gly		
465	470	475
Thr Asn Ala Asn Leu His Val Thr Ile Thr Ser Ser Gly Gln Asp Val		

485

490

495

Gly Val Ala Ala Ala Leu Ala Lys Thr Leu Glu Tyr Tyr Ala Ala Lys  
 500 505 510

Ser Gly Asp Thr Ala Ser Arg Asp Leu Ala Lys Gly Leu Leu Asp Ser  
 515 520 525

Met Trp Asn Asn Asp Gln Asp Ser Leu Gly Val Ser Thr Pro Glu Thr  
 530 535 540

Arg Thr Asp Tyr Ser Arg Phe Thr Gln Val Tyr Asp Pro Thr Thr Gly  
 545 550 555 560

Asp Gly Leu Tyr Ile Pro Ser Gly Trp Thr Gly Thr Met Pro Asn Gly  
 565 570 575

Asp Gln Ile Lys Pro Gly Ala Thr Phe Leu Ser Ile Arg Ser Trp Tyr  
 580 585 590

Thr Lys Asp Pro Gln Trp Ser Lys Val Gln Ala Tyr Leu Asn Gly Gly  
 595 600 605

Pro Ala Pro Thr Phe Asn Tyr His Arg Phe Trp Ala Glu Ser Asp Phe  
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Ala Met Ala Asn Ala Asp Phe Gly Met Leu Phe Pro Ser Gly Ser Pro  
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&lt;210&gt; 6

&lt;211&gt; 85

&lt;212&gt; PRT

&lt;213&gt; Acidothermus cellulolyticus

&lt;400&gt; 6

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Thr Thr Ser Ser Val Ser Leu Ser Trp Thr Ala Ser Thr Asp Asn Val  
 20 25 30

Gly Val Ala His Tyr Asn Val Tyr Arg Asn Gly Thr Leu Val Gly Gln  
 35 40 45

Pro Thr Ala Thr Ser Phe Thr Asp Thr Gly Leu Ala Ala Gly Thr Ser  
 50 55 60

Tyr Thr Tyr Thr Val Ala Ala Val Asp Ala Ala Gly Asn Thr Ser Ala  
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Gln Ser Phe Ala Gly  
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&lt;210&gt; 7

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<213> Acidothermus cellulolyticus

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35 40 45  
  
Asn Tyr Trp Asn Thr Ala Leu Thr Gln Ser Gly Lys Ser Val Thr Ala  
50 55 60  
  
Lys Asn Leu Ser Tyr Asn Asn Val Ile Gln Pro Gly Gln Ser Thr Thr  
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Ser Cys Thr Ala Ser  
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<213> Acidothermus cellulolyticus

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Thr Leu Ile Val Glu Ala Pro Asp Tyr Gly His Glu Thr Thr Ser Glu  
35 40 45  
  
Ala Tyr Ser Phe Trp Leu Trp Leu Glu Ala Thr Tyr Gly Ala Val Thr

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Gly Asn Trp Thr Pro Phe Asn Asn Ala Trp Thr Thr Met Glu Thr Tyr  
65                    70                    75                    80

Met Ile Pro Gln His Ala Asp Gln Pro Asn Asn Ala Ser Tyr Asn Pro  
85                    90                    95

Asn Ser Pro Ala Ser Tyr Ala Pro Glu Glu Pro Leu Pro Ser Met Tyr  
100                    105                    110

Pro Val Ala Ile Asp Ser Ser Val Pro Val Gly His Asp Pro Leu Ala  
115                    120                    125

Ala Glu Leu Gln Ser Thr Tyr Gly Thr Pro Asp Ile Tyr Gly Met His  
130                    135                    140

Trp Leu Ala Asp Val Asp Asn Ile Tyr Gly Tyr Gly Asp Ser Pro Gly  
145                    150                    155                    160

Gly Gly Cys Glu Leu Gly Pro Ser Ala Lys Gly Val Ser Tyr Ile Asn  
165                    170                    175

Thr Phe Gln Arg Gly Ser Gln Glu Ser Val Trp Glu Thr Val Thr Gln  
180                    185                    190

Pro Thr Cys Asp Asn Gly Lys Tyr Gly Gly Ala His Gly Tyr Val Asp  
195                    200                    205

Leu Phe Ile Gln Gly Ser Thr Pro Pro Gln Trp Lys Tyr Thr Asp Ala  
210                    215                    220

Pro Asp Ala Asp Ala Arg Ala Val Gln Ala Ala Tyr Trp Ala Tyr Thr  
225                    230                    235                    240

Trp Ala Ser Ala Gln Gly Lys Ala Ser Ala Ile Ala Pro Thr Ile Ala  
245                    250                    255

Lys Ala Ser Gln Thr Gly Asp Tyr Leu Arg Tyr Ser Leu Phe Asp Lys  
260                    265                    270

Tyr Phe Lys Gln Val Gly Asn Cys Tyr Pro Ala Ser Ser Cys Pro Gly  
275                    280                    285

Ala Thr Gly Arg Gln Ser Glu Thr Tyr Leu Ile Gly Trp Tyr Tyr Ala  
290                    295                    300

Trp Gly Gly Ser Ser Gln Gly Trp Ala Trp Arg Ile Gly Asp Gly Ala  
305                    310                    315                    320

Ala His Phe Gly Tyr Gln Asn Pro Leu Ala Ala Trp Ala Met Ser Asn  
325                    330                    335

Val Thr Pro Leu Ile Pro Leu Ser Pro Thr Ala Lys Ser Asp Trp Ala  
340                    345                    350

Ala Ser Leu Gln Arg Gln Leu Glu Phe Tyr Gln Trp Leu Gln Ser Ala

355

360

365

Glu Gly Ala Ile Ala Gly Gly Ala Thr Asn Ser Trp Asn Gly Asn Tyr  
370 375 380

Gly Thr Pro Pro Ala Gly Asp Ser Thr Phe Tyr Gly Met Ala Tyr Asp  
385 390 395 400

Trp Glu Pro Val Tyr His Asp Pro Pro Ser Asn Asn Trp Phe Gly Phe  
405 410 415

Gln Ala Trp Ser Met Glu Arg Val Ala Glu Tyr Tyr Val Thr Gly  
420 425 430

Asp Pro Lys Ala Lys Ala Leu Leu Asp Lys Trp Val Ala Trp Val Lys  
435 440 445

Pro Asn Val Thr Thr Gly Ala Ser Trp Ser Ile Pro Ser Asn Leu Ser  
450 455 460

Trp Ser Gly Gln Pro Asp Thr Trp Asn Pro Ser Asn Pro Gly Thr Asn  
465 470 475 480

Ala Asn Leu His Val Thr Ile Thr Ser Ser Gly Gln Asp Val Gly Val  
485 490 495

Ala Ala Ala Leu Ala Lys Thr Leu Glu Tyr Tyr Ala Ala Lys Ser Gly  
500 505 510

Asp Thr Ala Ser Arg Asp Leu Ala Lys Gly Leu Leu Asp Ser Met Trp  
515 520 525

Asn Asn Asp Gln Asp Ser Leu Gly Val Ser Thr Pro Glu Thr Arg Thr  
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Asp Tyr Ser Arg Phe Thr Gln Val Tyr Asp Pro Thr Thr Gly Asp Gly  
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Leu Tyr Ile Pro Ser Gly Trp Thr Gly Thr Met Pro Asn Gly Asp Gln  
565 570 575

Ile Lys Pro Gly Ala Thr Phe Leu Ser Ile Arg Ser Trp Tyr Thr Lys  
580 585 590

Asp Pro Gln Trp Ser Lys Val Gln Ala Tyr Leu Asn Gly Gly Pro Ala  
595 600 605

Pro Thr Phe Asn Tyr His Arg Phe Trp Ala Glu Ser Asp Phe Ala Met  
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Ala Asn Ala Asp Phe Gly Met Leu Phe Pro Ser Gly Ser Pro  
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Thr Leu Met Val Glu Ala Pro Asp Tyr Gly His Glu Thr Thr Ser Glu  
35 40 45

Ala Tyr Ser Tyr Trp Leu Trp Leu Glu Ala Leu Tyr Gly Gln Val Thr  
50 55 60

Gln Asp Trp Ala Pro Leu Asn His Ala Trp Asp Thr Met Glu Lys Tyr  
65 70 75 80

Met Ile Pro Gln Ser Val Asp Gln Pro Thr Asn Ser Phe Tyr Asn Pro  
85 90 95

Asn Ser Pro Ala Thr Tyr Ala Pro Glu Phe Asn His Pro Ser Ser Tyr  
100 105 110

Pro Ser Gln Leu Asn Ser Gly Ile Ser Gly Gly Thr Asp Pro Ile Gly  
115 120 125

Ala Glu Leu Lys Ala Thr Tyr Gly Asn Ala Asp Val Tyr Gln Met His  
130 135 140

Trp Leu Ala Asp Val Asp Asn Ile Tyr Gly Phe Gly Ala Thr Pro Gly  
145 150 155 160

Ala Gly Cys Thr Leu Gly Pro Thr Ala Thr Gly Thr Ser Phe Ile Asn  
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Thr Phe Gln Arg Gly Pro Gln Glu Ser Val Trp Glu Thr Val Pro Gln  
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Pro Ser Cys Glu Glu Phe Lys Tyr Gly Gly Lys Asn Gly Tyr Leu Asp  
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Leu Phe Thr Lys Asp Ala Ser Tyr Ala Lys Gln Trp Lys Tyr Thr Ser  
210 215 220

Ala Ser Asp Ala Asp Ala Arg Ala Val Glu Ala Val Tyr Trp Ala Asn  
225 230 235 240

Gln Trp Ala Thr Glu Gln Gly Lys Ala Ala Asp Val Ala Ala Thr Val  
245 250 255

Ala Lys Ala Ala Lys Met Gly Asp Tyr Leu Arg Tyr Thr Leu Phe Asp  
260 265 270

Lys Tyr Phe Lys Lys Ile Gly Cys Thr Ser Pro Thr Cys Ala Ala Gly  
275 280 285

Gln Gly Arg Glu Ala Ala His Tyr Leu Leu Ser Trp Tyr Met Ala Trp  
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Gly Gly Ala Thr Asp Thr Ser Ser Gly Trp Ala Trp Arg Ile Gly Ser  
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Ser His Ala His Phe Gly Tyr Gln Asn Pro Leu Ala Ala Trp Ala Leu  
325 330 335

Ser Thr Asp Pro Lys Leu Thr Pro Lys Ser Pro Thr Ala Lys Ala Asp  
340 345 350

Trp Ala Ala Ser Met Gln Arg Gln Leu Glu Phe Tyr Thr Trp Leu Gln  
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Ala Ser Asn Gly Gly Ile Ala Gly Gly Ala Thr Asn Ser Trp Asp Gly  
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Ala Tyr Ala Gln Pro Pro Ala Gly Thr Pro Thr Phe Tyr Gly Met Gly  
385 390 395 400

Tyr Thr Glu Ala Pro Val Tyr Val Asp Pro Pro Ser Asn Arg Trp Phe  
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Gly Met Gln Ala Trp Gly Val Gln Arg Val Ala Glu Leu Tyr Tyr Ala  
420 425 430

Ser Gly Asn Ala Gln Ala Lys Lys Ile Leu Asp Lys Trp Val Pro Trp  
435 440 445

Val Val Ala Asn Ile Ser Thr Asp Gly Ala Ser Trp Lys Val Pro Ser  
450 455 460

Glu Leu Lys Trp Thr Gly Lys Pro Asp Thr Trp Asn Ala Ala Ala Pro  
465 470 475 480

Thr Gly Asn Pro Gly Leu Thr Val Glu Val Thr Ser Tyr Gly Gln Asp  
485 490 495

Val Gly Val Ala Ala Asp Thr Ala Arg Ala Leu Leu Phe Tyr Ala Ala  
500 505 510

Lys Ser Gly Asp Thr Ala Ser Arg Asp Lys Ala Leu Leu Asp  
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Ala Ile Trp Ala Asn Asn Gln Asp Pro Leu Gly Val Ser Ala Val Glu  
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Thr Arg Gly Asp Tyr Lys Arg Phe Asp Asp Thr Tyr Val Ala Asn Gly  
545 550 555 560

Asp Gly Ile Tyr Ile Pro Ser Gly Trp Thr Gly Thr Met Pro Asn Gly  
565 570 575

Asp Val Ile Lys Pro Gly Val Ser Phe Leu Asp Ile Arg Ser Phe Tyr  
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Lys Lys Asp Pro Asn Trp Ser Lys Val Gln Thr Phe Leu Asp Gly Gly  
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Ala Gly Ala Leu Ala Asp Tyr Ala Arg Leu Phe Asp Asp Gly Thr Thr  
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Ser Val Glu Thr Met Ile Val Glu Ala Pro Asp His Gly His Gln Thr  
35 40 45

Thr Ser Glu Ala Phe Ser Tyr Tyr Leu Trp Leu Glu Ala Tyr Tyr Gly  
50 55 60

Arg Val Thr Gly Asp Trp Lys Pro Leu His Asp Ala Trp Glu Ser Met  
65 70 75 80

Glu Thr Phe Ile Ile Pro Gly Thr Lys Asp Gln Pro Thr Asn Ser Ala  
85 90 95

Tyr Asn Pro Asn Ser Pro Ala Thr Tyr Ile Pro Glu Gln Pro Asn Ala  
100 105 110

Asp Gly Tyr Pro Ser Pro Leu Met Asn Asn Val Pro Val Gly Gln Asp  
115 120 125

Pro Leu Ala Gln Glu Leu Ser Ser Thr Tyr Gly Thr Asn Glu Ile Tyr  
130 135 140

Gly Met His Trp Leu Leu Asp Val Asp Asn Val Tyr Gly Phe Gly Phe  
145 150 155 160

Cys Gly Asp Gly Thr Asp Asp Ala Pro Ala Tyr Ile Asn Thr Tyr Gln  
165 170 175

Arg Gly Ala Arg Glu Ser Val Trp Glu Thr Ile Pro His Pro Ser Cys  
180 185 190

Asp Asp Phe Thr His Gly Gly Pro Asn Gly Tyr Leu Asp Leu Phe Thr  
195 200 205

Asp Asp Gln Asn Tyr Ala Lys Gln Trp Arg Tyr Thr Asn Ala Pro Asp  
210 215 220

Ala Asp Ala Arg Ala Val Gln Val Met Phe Trp Ala His Glu Trp Ala  
225 230 235 240

Lys Glu Gln Gly Lys Glu Asn Glu Ile Ala Gly Leu Met Asp Lys Ala  
245 250 255

Ser Lys Met Gly Asp Tyr Leu Arg Tyr Ala Met Phe Asp Lys Tyr Phe  
260 265 270

Lys Lys Ile Gly Asn Cys Val Gly Ala Thr Ser Cys Pro Gly Gly Gln  
275 280 285

Gly Lys Asp Ser Ala His Tyr Leu Leu Ser Trp Tyr Tyr Ser Trp Gly  
290 295 300

Gly Ser Leu Asp Thr Ser Ser Ala Trp Ala Trp Arg Ile Gly Ser Ser  
305 310 315 320

Ser Ser His Gln Gly Tyr Gln Asn Val Leu Ala Ala Tyr Ala Leu Ser  
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Gln Val Pro Glu Leu Gln Pro Asp Ser Pro Thr Gly Val Gln Asp Trp  
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Ala Thr Ser Phe Asp Arg Gln Leu Glu Phe Leu Gln Trp Leu Gln Ser  
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Ala Glu Gly Gly Ile Ala Gly Gly Ala Thr Asn Ser Trp Lys Gly Ser  
370 375 380

Tyr Asp Thr Pro Pro Thr Gly Leu Ser Gln Phe Tyr Gly Met Tyr Tyr  
385 390 395 400

Asp Trp Gln Pro Val Trp Asn Asp Pro Pro Ser Asn Asn Trp Phe Gly  
405 410 415

Phe Gln Val Trp Asn Met Glu Arg Val Ala Gln Leu Tyr Tyr Val Thr  
420 425 430

Gly Asp Ala Arg Ala Glu Ala Ile Leu Asp Lys Trp Val Pro Trp Ala  
435 440 445

Ile Gln His Thr Asp Val Asp Ala Asp Asn Gly Gly Gln Asn Phe Gln  
450 455 460

Val Pro Ser Asp Leu Glu Trp Ser Gly Gln Pro Asp Thr Trp Thr Gly  
465 470 475 480

Thr Tyr Thr Gly Asn Pro Asn Leu His Val Gln Val Val Ser Tyr Ser  
485 490 495

Gln Asp Val Gly Val Thr Ala Ala Leu Ala Lys Thr Leu Met Tyr Tyr  
500 505 510

Ala Lys Arg Ser Gly Asp Thr Thr Ala Leu Ala Thr Ala Glu Gly Leu  
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Leu Asp Ala Leu Leu Ala His Arg Asp Ser Ile Gly Ile Ala Thr Pro  
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Glu Gln Pro Ser Trp Asp Arg Leu Asp Asp Pro Trp Asp Gly Ser Glu  
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Gly Leu Tyr Val Pro Pro Gly Trp Ser Gly Thr Met Pro Asn Gly Asp  
565 570 575

Arg Ile Glu Pro Gly Ala Thr Phe Leu Ser Ile Arg Ser Phe Tyr Lys  
580 585 590

Asn Asp Pro Leu Trp Pro Gln Val Glu Ala His Leu Asn Asp Pro Gln  
595 600 605

Asn Val Pro Ala Pro Ile Val Glu Arg His Arg Phe Trp Ala Gln Val  
610 615 620

Glu Ile Ala Thr Ala Phe Ala Ala His Asp Glu Leu Phe Gly Ala Gly  
625 630 635 640

Ala Pro